REMARKS

Claims 1-31 and 52-55 are pending in the application with claims 1, 3, 4, 8, 10, 20-22, and 26 amended herein, new claims 52-55 added herein, and claims 32-51 canceled herein as being drawn to a non-elected invention. Applicants hereby confirm the provisional election without traverse to prosecute the claims of Group I, Species a, claims 1-31.

Figs. 3 and 4 stand objected to as containing reference numerals 80 and 35, respectively, that are not mentioned in the description. Applicants herein amend paragraph 35 beginning on page 19 of the present specification to recite "a gate electrode 80." Included herewith as a separate paper, the Applicants also submit a revision to Fig. 4 showing removal of reference numeral 35 in red and a corrected Fig. 4 with the reference numeral 35 removed. Applicants request approval by the Examiner of the proposed change. In view of the amendments herein, Applicants request withdrawal of the drawing objection in the next Office Action.

Claims 1-4 stand rejected under 35 U.S.C. 102(e) as being anticipated by Bai. Applicants request reconsideration.

Claim 1 is amended herein incorporating all the subject matter of original claim 3, including any intervening claims, and overcomes all grounds of rejection for such claim. Because the subject matter of amended claim 1 appeared in original claim 3, any new ground of rejection must be presented in a non-final rejection.

Amended claim 1 sets forth a method of forming a dielectric layer that includes, among other features, forming a layer of silicon dioxide overlying at least one portion of a silicon-containing surface comprised by a substrate, forming a metal layer over the layer of silicon dioxide, and combining metal of the metal layer with oxygen of the silicon dioxide layer to form a metal oxide. The metal oxide is a first metal-containing dielectric layer and the metal includes an element selected from Group IVB of the Periodic Table. The method also includes forming a second metal-containing dielectric layer over the first metal-containing dielectric layer.

Pages 5-6 of the Office Action state that Bai anticipates claim 3. Specifically, the Office Action alleges that paragraph 18 of Bai discloses forming bottom dielectric layer 130 and combining metal of layer 130 with oxygen of underlying silicon dioxide to form a metal oxide dielectric material. Applicants note that paragraph 17 of Bai merely describes that gate dielectric material may be deposited by conventional techniques such as chemical vapor deposition. Bai does not in any way describe forming a metal layer over silicon dioxide and then combining metal of the metal layer with oxygen of the silicon dioxide layer to form a metal oxide. The only disclosure in Bai of deposition describes forming metal oxide in an as-deposited state, rather than forming a metal layer then combining the metal with oxygen to form a metal oxide, as claimed. Page 5 of the Office Action also alleges that Bai discloses forming a layer of silicon dioxide, referencing the numerical variable t_{ox} described in claim 4 of Bai. However, t_{ox} is merely a numerical value used solely for the sake of comparison to represent the equivalent thickness for a gate dielectric made

completely of silicon dioxide without including any metal oxide. Such fact is confirmed by reference to paragraphs 19 and 20 of Bai and elsewhere throughout the reference. Bai does not in any way describe forming a metal layer over silicon dioxide and combining metal of the metal layer with oxygen of the silicon dioxide layer.

It is clear from careful review of Bai that page 5 of the Office Action gives an inaccurate description of the disclosure of such reference with regard to claim 3. Bai does not provide any disclosure of even a suggestion of forming a metal layer. Mere description of forming a silicon dioxide gate dielectric does not constitute disclosure of forming a metal layer over a silicon dioxide layer and combining metal and oxygen into metal oxide. Also, mere disclosure of chemical vapor depositing a metal oxide does not constitute disclosure or suggestion of forming a metal layer over a layer of silicon dioxide. Bai does not even mention forming a metal oxide layer over a silicon dioxide layer, much less a metal layer over a silicon dioxide layer. On the contrary, Fig. 1 of Bai clearly shows and paragraph 18 clearly suggests that metal oxide of bottom dielectric layer 130 is formed directly on silicon, rather than on silicon dioxide. Bai states that bottom dielectric layer 130 should be stable "on silicon."

It is not seen how Bai can be considered to disclose or even suggest forming a metal layer over a silicon dioxide layer by any reasonable and technically accurate view of such reference. Certainly, one of ordinary skill would not view Bai as disclosing or suggesting forming a metal layer over a layer of silicon dioxide. Anticipation requires disclosure of each and every element. Bai does not disclose forming a metal layer over a

silicon dioxide layer and combining metal of the metal layer with oxygen of the silicon dioxide layer to form a metal oxide as a first metal-containing dielectric layer. Bai does not disclose any oxygen of a silicon dioxide layer combining with some other layer to form a metal-containing dielectric layer. Anticipation requires disclosure of each and every claim element. At least for the reasons described herein, Bai does not anticipate claim 1.

Claims 2-4 depend from claim 1 and are not anticipated at least for such reason as well as the additional limitations of such claims not disclosed. Accordingly, Applicants request allowance of claims 1-4 in the next Office Action.

Claims 1-4, 6-8, and 19 stand rejected under 35 U.S.C. 102(e) as being anticipated by Bai. Applicants request reconsideration.

The subject matter of claim 1 as amended herein to incorporate the subject matter of original claim 3 is described above. Page 5-6 of the Office Action allege that Roberts discloses the subject matter of claim 3. Since the present rejection is a 102 rejection over Bai, citing Roberts is inappropriate. The text of Roberts listed on page 6 of the Office Action corresponds only to the text of Bai. Accordingly, Applicants assume that reference to Roberts is a typographical error and that the reference should be to Bai instead. As already described above, Bai clearly does not disclose the subject matter of original claim 3, now amended claim 1. Applicants further assert, at least for the reasons described above regarding the first rejection of claim 1, that Bai does not suggest the subject matter of amended claim 1.

Claims 2-4, 6-8, and 19 depend from claim 1 and are not anticipated at least for such reason as well as the addition limitations of such claims not disclosed. For example, amended claim 8 sets forth that the metal layer comprises a hafnium-containing layer and the forming of the second metal-containing dielectric layer includes, among other features, forming a lanthanum-containing layer over the hafnium-containing layer and exposing the hafnium-containing layer and the lanthanum-containing layer to an oxygen comprising atmosphere. The method includes heating the hafnium-containing layer and the lanthanum-containing layer to a temperature effective to form a hafnium-containing dielectric layer and a lanthanum-containing dielectric layer. Page 6 of the Office Action alleges that paragraph 18 of Bai discloses the method of claim 8. Careful review of paragraph 18 does not reveal even a suggestion of exposing a hafnium-containing layer and a lanthanum-containing layer to an oxygen comprising atmosphere and heating the layers to form respective dielectric layers. Apparently, the citation to paragraph 18 is erroneous. Even so, thorough review of the remaining text of Bai does not reveal any disclosure of the claimed exposing to oxygen and heating to form a dielectric layer from hafnium-containing and lanthanum-containing layers. Thus, Bai does not anticipate amended claim 8.

Applicants assert that even the pertinence of Bai to original claim 8 is uncertain. Under 37 C.F.R. 1.104(c)(2) the pertinence of each reference if not apparent must be clearly explained. If the rejection is asserted again, then Applicants respectfully request clarification of the rejection of claim 8 with respect to Bai citing specific paragraph numbers

in support of the Office's allegations along with clear explanation of why a person of ordinary skill would view Bai as disclosing the alleged teachings. It is clear from Bai that the express teachings of the reference do not support an allegation of disclosing the subject matter of claim 8. The rejection of claim 8 is thus fatally defective for failure to comply with 37 C.F.R. 1.104(c)(2). If presented again with the required explanation of pertinence to claim 8, the rejection must be non-final.

At least for the reasons described above, Applicants assert that Bai does not anticipate claims 1-4, 6-8, and 19. Applicants request allowance of such claims in the next Office Action.

Claims 20, 23-25, and 30-31 stand rejected under 35 U.S.C. 102(e) as being anticipated by Bai. Applicants request reconsideration.

Claim 20 is amended herein incorporating all the subject matter of dependent claim 21 and any intervening claims. Since the subject matter of amended claim 20 was previously present in original claim 21, any new ground of rejection for amended claim 20 must be presented in a non-final rejection. Amended claim 20 sets forth a method for forming a MOS transistor that includes, among other features, providing a semiconductor substrate having a surface comprising silicon, forming a hafnium-containing dielectric layer overlying the surface, including first forming a hafnium-containing layer. The method includes forming a lanthanum-containing dielectric layer overlying the hafnium-containing dielectric layer, including second forming a lanthanum-containing layer. The first forming

and the second forming encompass physical vapor deposition and a gate electrode is formed over the hafnium-containing and lanthanum-containing dielectric layers.

Page 7-8 of the Office Action allege that Bai anticipates claim 20. However, page 10 of the Office Action acknowledges that Bai is deficient in disclosing every element of original claim 21 and relies on Roberts to remedy the deficiencies of Bai. Even so, page 10 of the Office Action merely relies on Roberts has allegedly disclosing physical vapor deposition. Bai is incorrectly alleged to teach forming a hafnium-containing dielectric layer, including first forming a hafnium-containing layer, and forming a lanthanum-containing dielectric layer, including second forming a lanthanum-containing layer. The Office Action does not cite any portion of Bai in support of such a teaching except paragraph 17 as allegedly disclosing first forming a hafnium-containing layer and second forming a lanthanum-containing layer.

Applicants note that the express language of claim 20 sets forth forming a hafnium-containing dielectric layer, including first forming a hafnium-containing layer. That is, a difference exists between a hafnium-containing dielectric layer and a hafnium-containing layer. For example, the difference can be in composition of the two layers or some other difference. Thorough review of Bai reveals that such reference does not even suggest forming a hafnium-containing dielectric layer in a method using different layers. On the contrary, paragraph 17 of Bai implies that hafnium oxide is the as-deposited material that results from chemical vapor deposition. Chemical vapor depositing hafnium oxide does not disclose or suggest first forming a hafnium-containing layer as a part of forming a

hafnium-containing dielectric layer. Amended claim 20 cannot be view in a manner such that chemical vapor depositing hafnium oxide is considered to disclose first forming a hafnium-containing layer and the same chemical vapor depositing hafnium oxide is also considered to disclose forming a hafnium-containing dielectric layer. Bai only describes depositing a hafnium oxide layer while claim 20 describes a hafnium-containing layer as well as a hafnium-containing dielectric layer. Accordingly, Bai cannot be considered to disclose or suggest such a feature of claim 20.

Similarly, even though Bai discloses a lanthanum oxide layer, Bai does not disclose or suggest forming a lanthanum-containing dielectric layer, including second forming a lanthanum-containing layer as claimed. Again, Bai merely describes chemical vapor depositing an as-deposited lanthanum oxide. Accordingly, Bai cannot be relied upon for teaching such features of amended claim 20 as alleged on page 10 of the Office Action regarding original claim 21. Bai thus does not anticipate amended claim 20. In addition, the Office Action does not allege that Roberts discloses such features. A finding of obviousness requires that the art combination suggests every element of the claimed method. Both Bai and Roberts are deficient in the same respects and a combination of such references cannot be considered to disclose or suggest every element of amended claim 20.

Claims 23-25, 30, and 31 depend from claim 20 and are not anticipated or obvious at least for such reason as well as the additional limitations of such claims not disclose or suggested. For example, claim 24 sets forth that forming the hafnium-containing and

lanthanum-containing dielectric layers includes exposing the hafnium and lanthanum-containing layers to an oxygen containing atmosphere while heating the hafnium and lanthanum layers to a temperature effective to form a hafnium-containing and a lanthanum-containing dielectric layer. Page 7 of the Office Action alleges that Bai teaches the subject matter of claim 24 but merely cites paragraphs 27 and 18 of Bai. Close review of the cited text does not reveal any teachings whatever of exposing material to an oxygen containing atmosphere while heating to convert the material to a dielectric layer. As previously established, Bai merely describes depositing a material including hafnium oxide or lanthanum oxide in its as-deposited state. No description exists of depositing some material that becomes hafnium oxide or lanthanum oxide after exposure to an oxygen containing atmosphere while heating. Accordingly, Bai cannot be considered to teach the subject matter alleged on page 7 of the Office Action and does not anticipate claim 24.

Applicants request allowance of claims 20, 23-25, 30, and 31 in the next Office Action.

Claims 5, 9-19 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Bai in view of Roberts. Applicants request reconsideration.

Claims 5 and 9-19 depend from claim 1. Applicants establish above in the discussion regarding claim 1 that Bai does not disclose or suggest forming a metal layer over a silicon dioxide layer and combining metal of the metal layer with oxygen of the silicon dioxide layer to form a metal oxide. Page 8 of the Office Action alleges that Roberts teaches providing conditions effective for hafnium of a metal layer to chemically reduce a

silicon dioxide layer. Careful review of Roberts column 3, lines 30-45 cited by the Office Action and the remainder of Roberts reveals that such reference does not disclose or suggest forming a metal layer over a silicon dioxide layer and combining metal of the metal layer with oxygen of the silicon dioxide layer to form a metal oxide. Roberts further does not disclose or suggest providing conditions effective for hafnium to chemically reduce a silicon dioxide layer.

The cited text merely describes forming hafnium nitride, which is not a metal layer, over a silicon dioxide layer 14. The hafnium nitride is oxidized into hafnium oxide, but column 3, lines 19-24 and column 4, lines 65-68 of Roberts clearly describe that the hafnium nitride is oxidized in dry oxygen at temperatures of 600 C or higher. Nowhere does Roberts provide any mention that oxygen of silicon dioxide layer 14 is combined with the hafnium nitride. Nowhere does Roberts provide any mention that silicon dioxide layer 14 is reduced. Rather, as discussed in paragraph 34 beginning on page 18 of the present specification, it is more likely that oxidizing hafnium nitride in dry oxygen while heating will not chemically reduce underlying silicon dioxide. Oxidizing in dry oxygen while heating merely provides the desired effect described in Roberts of oxidizing hafnium nitride without any effect on silicon dioxide layer 14 under the hafnium nitride.

Accordingly, Roberts does not disclose forming a metal layer over a silicon dioxide layer and combining metal of the metal layer with oxygen of the silicon dioxide layer to form a metal oxide, as set forth in claim 1. As established above in the discussion regarding claim 1, Bai also does not disclose such a method. In addition, page 8 of the

Office Action incorrectly alleges that Roberts teaches providing conditions effective for hafnium to chemically reduce a silicon dioxide layer. As a result, Roberts cannot be considered to somehow disclose or suggest the general concept of forming a material over a silicon dioxide layer and combining the material with oxygen of the silicon dioxide layer to form an oxide. At least for such reason, claim 1 is patentable over Bai and Roberts considered alone or in combination. Claims 5 and 9-19 depend from claim 1 and are patentable at least for such reason as well as the additional limitations of such claims not disclosed or suggested.

For example, claim 5 depends from amended claim 4, in turn depending from claim 1, and sets forth that combining metal of the metal layer with oxygen of the silicon dioxide layer includes providing conditions effective for the hafnium of the metal layer to chemically reduce the silicon dioxide layer. Bai is not alleged to provide any such teaching. As established above, Roberts further does not disclose or suggest the subject matter of claim 5. Since both references are deficient in the same respect, combination of the references cannot be somehow considered to disclose or suggest the element of claim 5 missing from their disclosure. Claim 5 is thus patentable.

Also for example, claim 10 depends from claim 8 in turn depending from claim 1 and sets forth that exposing the hafnium-containing layer and to the lanthanum-containing layer to an oxygen containing atmosphere includes ion bombardment of the hafnium-containing layer and the lanthanum-containing layer using an ion bombardment energy of about 10 electron volts or less. Page 9 of the Office Action erroneously states that "ion

bombardment (PVD) and conditions are well known in the art." Applicant notes that the ion bombardment of claim 10 expressly relates to exposing the layers to an oxygen containing atmosphere and not to PVD. Thorough review of both Bai and Roberts reveals that neither reference provides any disclosure or suggestion of exposing a hafnium-containing layer and a lanthanum-containing layer to an oxygen containing atmosphere by ion bombardment of the layers. The references further do not disclose or suggest using an ion bombardment energy of about 10 electron volts or less. Page 9 of the Office Action incorrectly states that such exposure to an oxygen containing atmosphere using ion bombardment is well known in the art. The Office Action does not provide any evidence in support of the bare allegation. The Office is required to cite a reference in support of the allegation. Claim 10 is thus patentable.

Claim 11 depends from claim 10 described above and sets forth that heating the hafnium-containing layer and the lanthanum-containing layer to a temperature effective to form a hafnium-containing dielectric layer and a lanthanum-containing dielectric layer includes heating to a temperature from about 200 C to about 400 C during the ion bombardment. Page 9 of the Office Action alleges that Roberts suggests the claimed temperature range with disclosure of oxidizing temperatures of 600 C or higher. As indicated above, Roberts does not disclose or suggest ion bombardment. Thus, it is impossible for Roberts to suggest heating to a temperature from about 200 C to about 400 C during ion bombardment.

Further, the Office Action does not provide any support for a suggestion or motivation to modify the express temperature range of Roberts in order to disclose the much lower claimed range. It is entirely improper for the Office to reference an oxidation temperature of 600 C or higher and merely state that it suggests an ion bombardment temperature from about 200 C to about 400 C. The mere fact that the prior art can be modified does not make the modification obvious "unless the prior art suggested the desirability of the modification." In re Gordon, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984). Roberts does not provide any indication of a desirability to modify an oxidation temperature of 600 C or higher by lowering it to about 200 C to about 400 C. Roberts also does not provide any indication that the oxidation temperature can be properly used for the ion bombardment set forth in claim 11.

Page 9 of the Office Action states that "where the general conditions of the claims are disclosed in the prior art, it is inventive [sic] to discover the optimum or workable range by routine experimentation." The quoted text appears to have some typographical error and does not expressly support the Office's assertions. Regardless, Applicants assert that the "general conditions" of claim 11 are not in any way disclose or suggested in the cited art. The art does not provide any mention of exposing layers to an oxygen comprising atmosphere using ion bombardment. Thus, it is insufficient to state that the claimed temperature range can be discovered by routine experimentation. At least for the reasons stated, claim 11 is patentable.

Claim 12 depends from claim 8, in turn depending from claim 1, and sets forth that exposing the layers to an oxygen containing atmosphere includes positioning the substrate within a reaction chamber and exposing the hafnium-containing layer and the lanthanum-containing layer to oxygen radicals within the reaction chamber. Page 10 of the Office Action incorrectly alleges that the oxidizing process cannot occur without exposing the layers to oxygen radicals and concludes that any oxidizing thus inherently discloses exposure to oxygen radicals. Paragraph 34 beginning at page 18 of the present specification describes one example of providing oxygen radicals. The specification shows and Applicants assert that providing oxygen radicals is merely one preferred embodiment of the claimed method and is not required to form a hafnium-containing or lanthanum-containing dielectric layer from a hafnium or lanthanum-containing layer. The Office does not provide <u>any</u> technical reasoning in support of the allegation that the oxidizing process cannot occur without oxygen radicals. Applicants assert that the Office's allegations are incorrect and that none of the cited references disclose or suggest the subject matter of claim 12. Claim 12 is thus patentable.

Claims 21, 22, and 26-29 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Bai in view of Roberts. Applicants request reconsideration.

The subject matter of original claim 21 is herein incorporated into amended claim 20. In the discussion above regarding anticipation of amended claim 20, Applicant establishes that Bai does not disclose or suggest forming a hafnium-containing dielectric layer, including first forming a hafnium-containing layer, and forming a lanthanum-

containing dielectric layer, including second forming a lanthanum-containing layer. In addition, the Office Action does not allege that Roberts discloses such features. A finding of obviousness requires that the art combination suggests every element of the claimed method. Both Bai and Roberts are deficient in the same respects and a combination of such references cannot be considered to disclose or suggest every element of original claim 21, now amended claim 20.

Claims 21, 22, and 26-29 depend from amended claim 20 and are patentable at least for such reason as well as the limitations of such claims not disclosed or suggested. For example, claim 26 depends from claim 24, in turn depending from claim 20. Claim 24 sets forth that forming the hafnium-containing dielectric layer and the lanthanum-containing dielectric layer includes exposing the hafnium and lanthanum-containing layers to an oxygen containing atmosphere while heating the hafnium and lanthanum-containing layers to a temperature effective to form a hafnium-containing dielectric layer and a lanthanum-containing dielectric layer. Claim 26 sets forth that the heating occurs at a temperature from about 200 C to about 400 C. Page 11 of the Office Action alleges that Roberts suggests the claimed temperature range with disclosure of temperatures of 600 C or higher. However, the Office Action does not provide any support for a suggestion or motivation to modify the express temperature range of Roberts in order to disclose the much lower claimed range. It is entirely improper for the Office to reference a temperature of 600 C or higher and merely state that it suggests a temperature from about 200 C to about 400 C. The mere fact that the prior art can be modified does not make the

modification obvious "unless the prior art suggested the desirability of the modification." In re Gordon, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984). Roberts does not provide any indication of a desirability to modify a temperature of 600 C or higher by lowering it to about 200 C to about 400 C. Thus, claim 26 is patentable over the cited combination.

Also for example, claim 27 depends from claim 25, in turn depending from claim 24 and then to claim 20. Claim 27 sets forth forming the hafnium-containing layer over a layer of silicon dioxide and providing conditions effective for the hafnium-containing layer to chemically reduce the silicon dioxide layer to form hafnium oxide as the hafnium-containing dielectric layer. Page 11 of the Office Action alleges that Bai discloses hafnium oxide layer 130 formed over a layer of silicon dioxide (t_{ox}), citing Fig. 1 and claim 4. However, t_{ox} is merely a numerical value used solely for the sake of comparison to represent the equivalent thickness for a gate dielectric made completely of silicon dioxide without including any metal oxide. Such fact is confirmed by reference to paragraphs 19 and 20 of Bai and elsewhere throughout the reference. Bai does not in any way describe forming a hafnium-containing layer over silicon dioxide, as claimed. It is clear from careful review of Bai that page 11 of the Office Action gives an inaccurate description of the disclosure of such reference with regard to claim 27. Fig. 1 of Bai clearly shows and paragraph 18 clearly suggests that bottom dielectric layer 130 is formed directly on silicon, rather than on silicon dioxide. Bai states that bottom dielectric layer 130 should be stable "on silicon."

Page 11 of the Office Action also alleges that Roberts teaches providing conditions effective for a hafnium-containing layer to chemically reduce a silicon dioxide layer. Careful review of Roberts column 3, lines 30-45 cited by the Office Action and the remainder of Roberts reveals that such reference does not disclose or suggest providing conditions effective to chemically reduce a silicon dioxide layer. The cited text merely describes forming hafnium nitride over a silicon dioxide layer 14. The hafnium nitride is oxidized into hafnium oxide, but column 3, lines 19-24 and column 4, lines 65-68 of Roberts clearly describe that the hafnium nitride is oxidized in dry oxygen at temperatures of 600 C or higher. Nowhere does Roberts provide any mention that silicon dioxide layer 14 is reduced. Rather, as discussed in paragraph 34 beginning on page 18 of the present specification, it is more likely that oxidizing hafnium nitride in dry oxygen while heating will not chemically reduce underlying silicon dioxide. Oxidizing in dry oxygen while heating merely provides the desired effect described in Roberts of oxidizing hafnium nitride without any effect on silicon dioxide layer 14 under the hafnium nitride.

Accordingly, page 11 of the Office Action incorrectly alleges that Bai teaches hafnium oxide layer 130 formed over a layer of silicon dioxide. Page 11 also incorrectly alleges that Roberts teaches providing conditions effective for a hafnium-containing layer to chemically reduce a silicon dioxide layer. At least for such reasons, claim 27 is patentable over Bai and Roberts considered alone or in combination.

As a further example, claim 28 depends from claim 25, in turn depending from claim 24 and then to claim 20. Claim 28 sets forth providing ion bombardment of the hafnium-

containing and lanthanum-containing layers using an ion bombardment energy of about 10 electron volts or less and heating during ion bombardment from about 200 C to about 400 C. As discussed above regarding claim 11, neither Bai nor Roberts provide any disclosure or suggestion of such features. Claim 28 is thus patentable.

In view of the remarks above, claims 21, 22, and 26-29 are patentable over Bai in view of Roberts. Applicants request allowance of such claims in the next Office Action.

Applicants herein establish adequate reasons for allowance of claims 1-31 and 52-55. Applicants request allowance of all pending claims in the next Office Action.

Respectfully submitted,

Date 28 May 2002 Signed _____

James E Lake
Reg. No. 44,854

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Filing Date ..... June 13, 2001
Inventor ..... Kie Y. Ahn, et al
Assignee..... Micron Technology, Inc.
Group Art Unit 2814
Examiner ..... T. Le
Attorney's Docket No. MI22-1534
Title: A Dielectric Layer Forming Method and Devices Formed Therewith

VERSION WITH MARKINGS TO SHOW CHANGES MADE ACCOMPANYING RESPONSE TO FEBRUARY 26, 2002 OFFICE ACTION

In the Specification

The replacement specification paragraphs incorporate the following amendments. Underlines indicate insertions and ~~strikeouts~~ indicate deletions.

Paragraph 35 beginning on page 19 has been amended as follows:

Referring to Fig. 3, an MOS transistor 14 formed in accordance with embodiments of the present invention is depicted. Gate dielectric 60 is disposed over a portion of surface 22 of substrate 20 as well as adjacent to and elevationally above source/drain (S/D) regions 24. In accordance with embodiments of the present invention, gate dielectric 60 encompasses metal-containing dielectric layers 45 and 55 (Fig. 2) where such layers are formed as described above and subsequently patterned using any of the appropriate methods for patterning a gate electrode 80 and dielectric 60. S/D regions 24 and sidewall spacers 70 are also formed by appropriate methods. It will be understood that transistor 14 is a simplified transistor representation, and that more complex transistor

structures are also encompassed by embodiments of the present invention. For example, in some embodiments, transistor 14 is a MOSFET having an gate dielectric layer 60 that has an equivalent oxide thickness (EOT) of 2 nm or less while having an actual thickness of as much as about 6 nm. Such an advanced MOSFET can also have a gate length of about 0.25 micron or less and be encompassed within an integrated circuit such as a dynamic random access memory (DRAM), static random access memory (SRAM) or any of the various other memory integrated circuits. Transistor 14 can also encompass a gate dielectric layer 60 that has an EOT of greater than 2 nm and a gate length of more than 0.25 micron.

In the Claims

The claims have been amended as follows. Underlines indicate insertions and ~~strikeouts~~ indicate deletions.

1. (amended) A method of forming a dielectric layer comprising:

providing a substrate comprising a silicon-containing surface;

forming a layer of silicon dioxide overlying at least one portion of the surface;

forming a metal layer over the layer of silicon dioxide; combining metal of the metal layer with oxygen of the silicon dioxide layer to form a metal oxide as ~~forming~~ a first metal-containing dielectric layer over the surface, the metal comprising an element selected from Group IVB of the periodic table; and

forming a second metal-containing dielectric layer over the first metal-containing dielectric layer.

3. (amended) The method of Claim 1, ~~further comprising:~~

~~forming a layer of silicon dioxide overlying at least one portion of the surface;~~ ~~and~~

~~wherein forming the first metal-containing dielectric layer comprises;~~

~~forming a metal layer over the layer of silicon dioxide; and~~

~~combining metal of the metal layer with oxygen of the silicon dioxide layer to form a metal oxide dielectric material~~ wherein the second metal-containing dielectric layer is formed on the first metal-containing dielectric layer.

4. (amended) The method of Claim ~~3~~ 1, wherein the metal layer comprises hafnium.

8. (amended) The method of Claim 1, where the metal layer comprises a hafnium-containing layer and the forming of ~~the first metal-containing dielectric layer and~~ the second metal-containing dielectric layer ~~comprise~~ comprises:

~~forming a hafnium-containing layer;~~

forming a lanthanum-containing layer over the hafnium-containing layer; and

exposing the hafnium-containing layer and the lanthanum-containing layer to an oxygen comprising atmosphere and heating the hafnium-containing layer and the lanthanum-containing layer to a temperature effective to form a hafnium-containing dielectric layer and a lanthanum-containing dielectric layer.

10. (amended) The method of Claim 8, where the exposing comprises ion bombardment of the ~~first~~ hafnium-containing layer and the lanthanum-containing layer using an ion bombardment energy of about 10 electron volts (eV) or less.

20. (amended) A method for forming ~~an~~ a MOS transistor, comprising:

providing a semiconductor substrate having a surface comprising silicon;

forming a hafnium-containing dielectric layer overlying the surface, including first forming a hafnium-containing layer;

forming a lanthanum-containing dielectric layer overlying the hafnium-containing dielectric layer, including second forming a lanthanum-containing layer, the first forming and the second forming encompassing physical vapor deposition; and

forming a gate electrode over the hafnium-containing and lanthanum-containing dielectric layers.

21. (amended) The method of Claim 20, ~~where:~~

~~the forming of the hafnium-containing dielectric layer dielectric layer comprises first forming a hafnium-containing layer; the forming of the lanthanum-containing dielectric layer comprises second forming a lanthanum-containing layer; and~~

~~wherein the first forming and the second forming encompass physical vapor deposition~~ wherein the lanthanum-containing dielectric layer is formed on the hafnium-containing dielectric layer.

22. (amended) The method of Claim ~~21~~ 20, where physical vapor deposition comprises electron beam evaporation.

26. (amended) The method of Claim 24, where the heating comprises heating the hafnium and lanthanum containing layers to a temperature from about 200°C ~~and~~ to about 400°C.

-END OF DOCUMENT-